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UNPUBLISHED PRELIMINARY DATA

OTS PRICE

XEROX	\$ 1.00 <i>ps</i>
MICROFILM	\$.50 <i>mf</i>

During the previous year techniques have been sufficiently developed to obtain significant information, which although qualitative, has served to define the immediate research objectives for the near future. In particular, I. Gupta has completed a survey of the behavior of carbon in tungsten which has been accepted for an M.S. thesis. Technical Report No. 1 has been prepared based on his work and the abstract of Technical Report No. 1 is attached as Appendix A of this report. M. Attardo working with Prof. J. Galligan has surveyed the effect of neutron damage in platinum, a representative f.c.c. metal. A brief summary of their results to date is given in Appendix B of this report. Also, A. Tobin working with Prof. J. Galligan has finally succeeded in eliminating the leaks from the ultra high vacuum system. This unit will initially be used by Prof. Galligan and J. Papazian to study the feasibility of an "excited state" helium microscope. The latter has completed design studies for the additional components required for this microscope which will be constructed and tested in the coming year.

APPENDIX A

A SURVEY OF THE BEHAVIOR IN TUNGSTEN
AS REVEALED BY FIELD ION MICROSCOPY

I. Gupta, E. S. Machlin, and J. Galligan

Abstract:

Field ion micrographs have been obtained from tungsten and tungsten-carbon alloys which have been subjected to a variety of heat treatments. It has been found that carbon in tungsten stabilizes the formation of stacking faults. An estimate has been obtained for the binding energy of carbon to stacking faults in tungsten which is 1 ± 0.25 e.v., based on the minimum temperature for annealing out the stacking faults (3000°C). Surfaces in tungsten have a much higher binding energy for carbon based on the observation that stacking faults in tips of about 10^{-6} cm diameter can be annealed out at much lower temperatures. The true lattice solid solubility of carbon in tungsten is probably much smaller than previously reported. The field evaporation potential for carbon exceeds that for tungsten. It is orientation sensitive and greatest in the vicinity of the (100) poles at the surface.

APPENDIX B

SUMMARY OF PRELIMINARY FIELD ION MICROSCOPE OBSERVATIONS OF POINT DEFECTS IN PLATINUM

Introduction

One of the main objectives of this research is to clarify by the means of direct observation in the field ion microscope, the interpretation of the recovery spectrum after either quenching, irradiation or cold work that previously has been inferred by indirect measurements. Among the points at issue are:

- 1) Concentration of interstitials and their distribution after Stage I recovery.
- 2) Role of impurities in the nucleation of point defect clusters.
- 3) The point defects responsible for recovery in Stages II, III and IV.
- 4) Size dependence of radiation damage.

Experimental Procedure

Relatively pure platinum (99.999) wire was irradiated in the Hudson Laboratories of Columbia University to 10^{10} , 10^{18} and 10^{20} nvt. at room temperature. (In platinum, Stage III recovery occurs 100°C above room temperature. The temperature in the pile did not exceed 70°C .) After irradiation a radioactive activation analysis revealed no serious contamination. Tips were made from the irradiated wire by electropolishing in KCN solution, floating on carbon tetrachloride. Examination was then undertaken in a glass microscope, evacuated to 10^{-7} m.m. Hg., after which helium was admitted through a heated vycor tube. A titanium getter was subsequently heated to remove any active gases such as oxygen or nitrogen. With this procedure stable images were obtained. The

cold finger of the field ion microscope was maintained at 78°K throughout the measurements.

Results and Discussion

One of the more striking results of this investigation has been the observation of clusters of interstitials in the irradiated platinum, fig. 1. These are distinguished from atoms in normal positions in the following way.

i. At equivalent positions the observed intensity is disproportionately high.

ii. Long time observation, about fifteen minutes, of some particular bright spots has revealed that a bright spot can disappear when some atoms pop out onto the surface. This indicates that the bright spot is associated with a large center of stress, specifically some atoms in interstitial positions. This only occurs when very careful field evaporation is undertaken and the bright spot is very close to the surface.

The observed shapes of these interstitial clusters vary from squares to lines and to triangles. From this it can be inferred that one shape that interstitial clusters take is that of a tetrahedron.

Another interesting observation is concerned with the occurrence of interstitial clusters in the less heavily damaged regions, fig. 2.

The minimum number of atoms associated with the interstitial clusters in these regions appears to be two. Vacancy clusters are also observed. The concentration of single vacancies is very small compared to the observed concentration of clusters. Single interstitials have not been observed.

Conclusions:

From the work to date it is apparent that interstitial clusters are stable in platinum at room temperature (below Stage III recovery.) This observation by itself does not completely clarify the interpretation of the recovery stages. The recovery treatments necessary to distinguish between alternate interpretations are presently underway. The observation, however, does set a necessary condition for any interpretation of the Stage III and IV recovery. Furthermore, neither Stage I or II can involve the complete removal of interstitials.

Because, the probability of motion of single vacancies in the specimens observed is small, it is likely that the observed vacancy clusters formed during irradiation, much as indicated by the machine calculations of Vineyard⁽¹⁾.

The investigation is still in too early a stage to conclude more than the above.

References

1. Vineyard, G.: Radiation Hardening in the book "Strengthening Mechanisms in Solids". A.S.M. Seminar Series, 1962.



Fig. 1. Neutron irradiated platinum 10^{18} nvt showing clusters of interstitials.

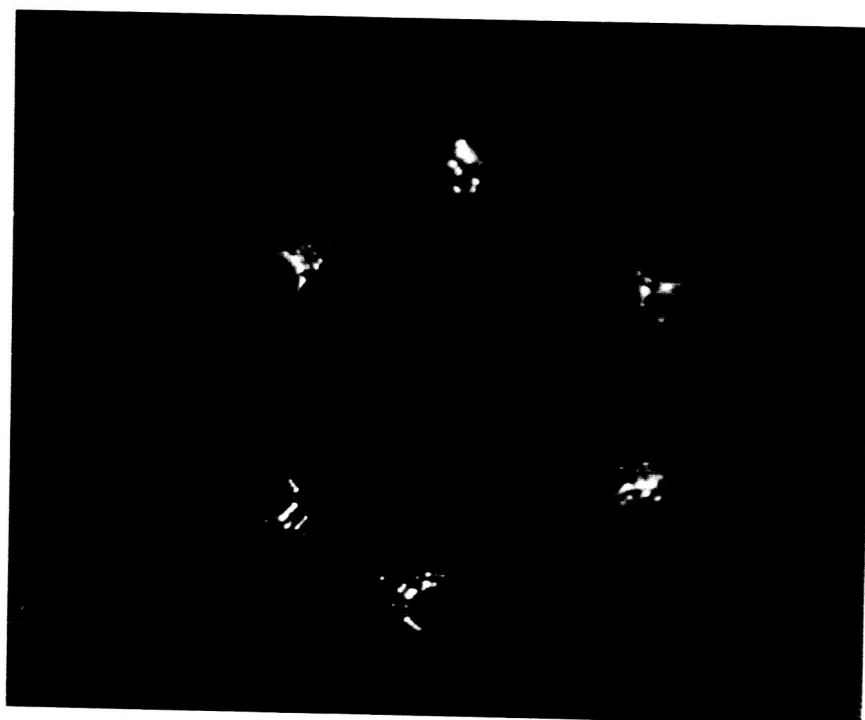


Fig. 2. Interstitials and vacancies in less heavily damaged regions of irradiated platinum.